Agriculture
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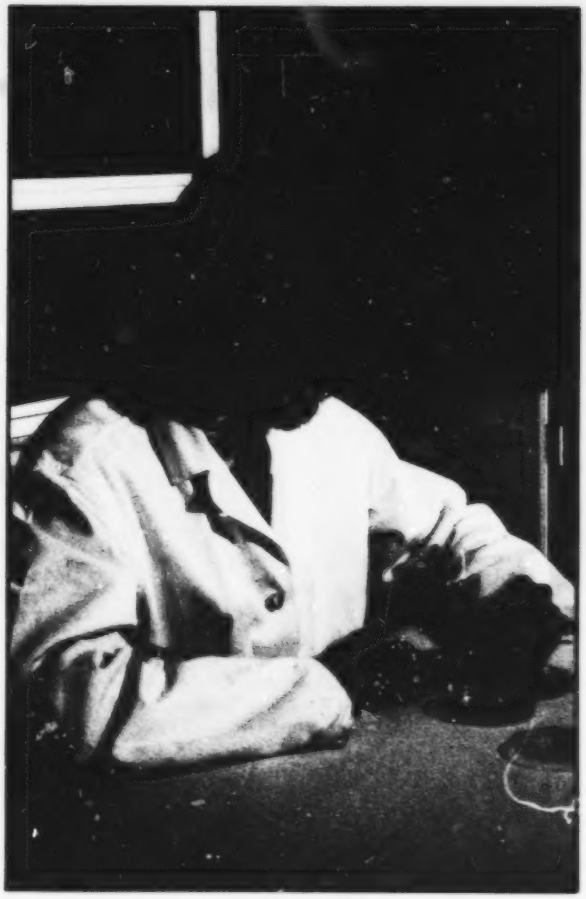

GRAIN RESEARCH LABORATORY

1984-1985 REPORT

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COMMISSION

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1984-1985 REPORT of the GRAIN RESEARCH LABORATORY

58th Report

The Grain Research Laboratory is a division of the Canadian Grain Commission and functions within the terms of reference of the Canada Grain Act (1971). The work of the Laboratory falls into five general areas as follows: an annual survey of the end-use quality of each successive new crop of Canadian grains and oilseeds undertaken during and immediately following the harvest; a continuing survey of the end-use quality of Canadian grains and oilseeds entering the domestic and export markets; a continuous monitoring of both the domestic and export marketings of Canadian grains to ensure freedom from contamination by fungicide and pesticide chemicals used both in agriculture and in the grain handling system; an annual evaluation of the potential end-use quality characteristics of plant breeders' cultivars of red spring and amber durum wheats, malting barleys and canola/rapeseed prior to the licensing of new varieties and their subsequent introduction into Canadian agriculture; a broad based program of grains and oilseeds research with the objective of continuously expanding our understanding of what constitutes quality, and what quality characteristics are required in Canadian grains so that they may be utilized effectively within today's rapidly changing technology.

This report summarizes the activities of the Grain Research Laboratory for the 15 month period January 1, 1984 to March 31, 1985. Highlights of the basic and applied research studies underway or completed during this period are described. Short summaries of a series of annual studies of the quality of 1984 crops of some Western Canadian and Eastern Canadian grains and oilseeds are presented. Brief descriptions of a series of important annual studies to assess the quality of newly developed cultivars of red spring wheat, amber durum wheat and barley are also given. These latter tests are part of the overall Canadian program which results ultimately in the licensing of new grain varieties and their subsequent growing by Canadian farmers. The final section of the report lists scientific and technical committees of which Laboratory personnel are members as well as scientific and technical meetings attended by staff; it lists the scientific and technical papers published by Laboratory staff during the period; and finally it lists the complete staff of the Laboratory.

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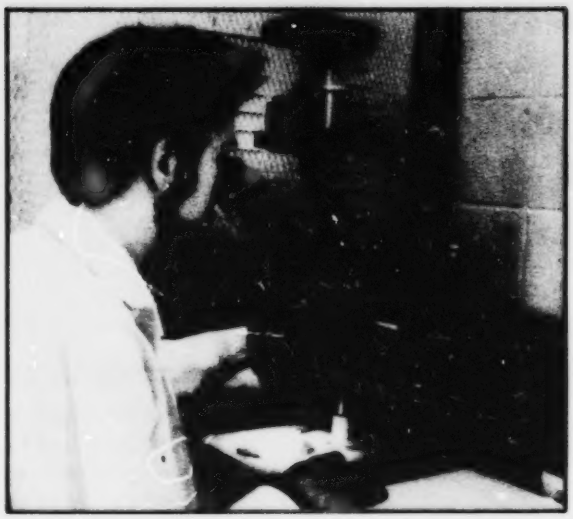
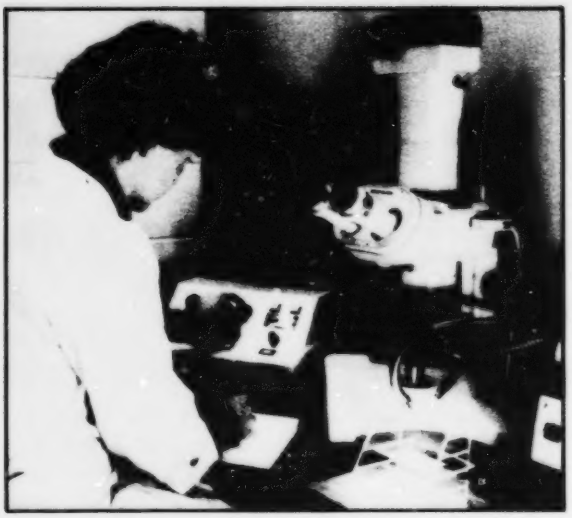


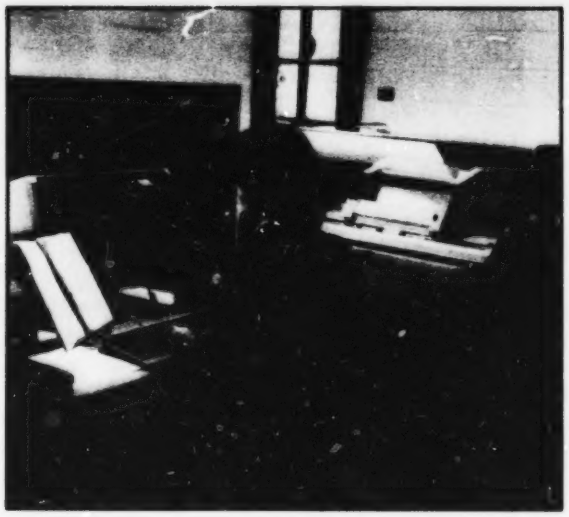
The establishing of a Mycology section in the Research Laboratory was mentioned in the previous report. The objective of the Mycology section, which became operational in April 1984, is to increase knowledge of the mycoflora present on Canadian grains, oilseeds and other seed crops. The Mycology section works very closely with the Grain Inspection Division of the Canadian Grain Commission and is also involved in collaborative projects with the Stored Products section of the Agriculture Canada Research Section, Winnipeg, Manitoba.



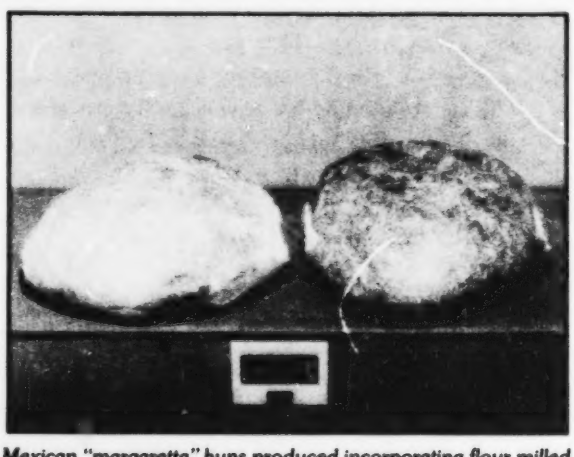
A Grain Quality Biology section was established in the Research Laboratory in the latter part of 1984 with the addition to the staff of Louise Cooke, BSA, an accredited Seed Analyst. The work of the section involves investigating and documenting problems encountered in the grading of grain. A reference collection of authenticated examples is being built up. Photomicrography is used to record detailed characteristics of each grading factor or problem. Then attempts are made to find the cause of the problem. Finally the effect of the problem on the end-use quality of the grain is explored. The Grain Quality Biology section and the Mycology section work closely together and constitute a newly established Grain Biology Research section of the Laboratory.

The Laboratory increased its research capability during the period under review by the acquisition of a number of items of new equipment. The Pesticide Residues section acquired a Hewlett-Packard mass selective detector (MSD) spectrometer which has been interfaced with a capillary-column gas chromatograph. The unit is being used for the confirmation of suspected pesticide residues and for detection of vomitoxin. The possibility of using the MSD unit for the detection of other mycotoxins in grain is being studied. Computers are being utilized to an ever increasing extent in the Laboratory.

Five microcomputers were purchased in 1984.
The Barley Malting and Quality Studies section, the Data Processing section, the Breadmaking Research section and the Director have IBM-PC units, while the Oilseeds section has a Digital Professional 350 model. As well the computer of the Waters high performance liquid chromatograph (HPLC) system is being progressively updated and new software has been purchased. This has increased data storage capacity and provides greater flexibility in the comparison of stored chromatograph data and will markedly assist in the identification of wheat and barley cultivars. An HPLC unit has just been acquired by the Oilseeds Section to be used for the determination of glucosinolates and chlorophyll in rapeseed.



Facilities of the general office too are being upgraded. The Laboratory's word processing capabilities, which include a Micom 2000 acquired in 1979 and a Micom 2001 acquired in 1982, have been expanded by the addition of a Micom 3004 acquired in March 1985. The word processing equipment has been an important element in a continuing program to upgrade the quality of Research Laboratory periodical publications. Telecommunication to commercial phototypesetters of complete manuscripts of Laboratory new crop bulletins and the Laboratory annual report began in 1981. Then in 1983 the Laboratory's graphics section undertook the complete paste-up preparation of the detailed camera-ready page layouts for the periodical publications. One further step in the publication process was undertaken by the Laboratory in 1984 with the photography of the detailed page layouts and the preparation of page negatives ready for plate-making by the printer.

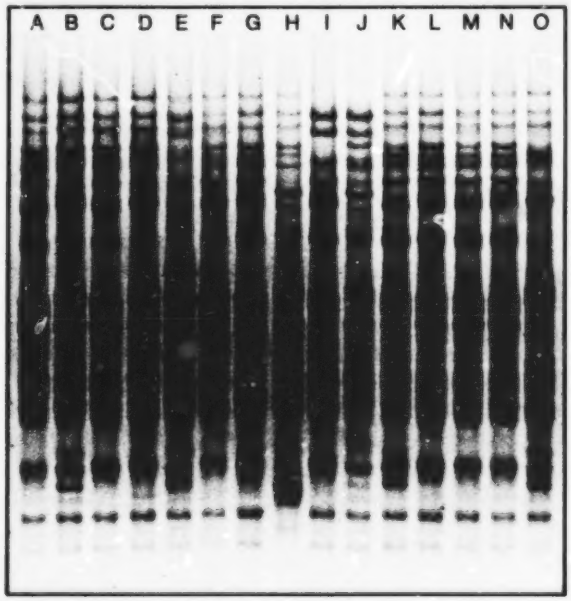


Mexican "margaretta" buns produced incorporating flour milled from HY320 wheat.

The technical expertise of the Research Laboratory staff was called upon in connection with the creation of a new class of wheat, Canadian Prairie Spring Wheat. This class was established to accommodate the new high yielding red spring wheat cultivar, HY320, licensed in January 1985 by Plant Products Division of Agriculture Canada. HY320, unlike the traditional Canadian spring wheats, is of "medium protein content, medium grain hardness and medium gluten strength". Staff members made visits to several overseas countries to assess the potential acceptability of HY320. In some cases, test parcels of HY320 were provided for evaluation by the industry in the particular market area with the milling, baking and other end-use processing of HY320 supervised by Research Laboratory personnel.

Laboratory personnel also provided considerable technical assistance in the identification of unlicensed varieties of wheat. In recent years, large numbers of "semi-dwarf" cultivars of wheat have been developed by plant breeders in different countries in attempts to increase wheat yields. Unfortunately, many of these high yielding semi-dwarf wheats obtain their higher yield at the expense of significantly lower protein content and in some cases exhibit serious quality deficiencies such as low water absorption or undesirably long dough mixing requirements. Such wheats are unacceptable for licensing in Canada and therefore are not eligible for the top grades of Canadian wheat. A particular difficulty in Canada with some of the new high yielding semi-dwarf cultivars developed in the United States is that their kernel characteristics as assessed visually very closely resemble those of licensed Canadian wheat varieties. Added to this, growing conditions in certain years, particularly hot dry weather, contribute even further to the problem of visual distinguishability between licensed Canadian varieties and unlicensed, undesirable varieties. Accordingly, the Laboratory has continued to expand its library of electrophoregrams, or "fingerprints" of the alcohol-soluble proteins of conventional height and semi-dwarf wheat cultivars. As well, the Laboratory has carried out the chemical identification or "fingerprinting" of wheat samples submitted by the Grain Inspection Division that are suspected to contain unlicensed cultivars. This varietal identification program now includes a continuous monitoring of the carlot movement of wheat into terminal elevators as well as the wheat cargoes exported from terminal elevators.

Interpreting electrophoregram patterns to identify the wheat cultivar.



Gliadin electrophoregrams of the wheat cultivars Neepawa (A), Columbus (B), Katepwa (C), Park (D), HY320 (E), Benito (F), Leader (G), Glenlea (H), Sinton (I), Selkirk (J), Canuck (K), Manitou (L), Napayo (M), Thatcher (N), and Chester (O).

In another project, the Research laboratory carried out a series of modifications to three Dickey-john GAC III near infrared reflectance spectrophotometers to permit the instruments to be used to measure quantitatively the chlorophyll content of rapeseed. These modified instruments were installed in terminal elevators on a trial basis in Vancouver in mid-1984. Satisfactory quantitative measurement of rapeseed chlorophyll was achieved by terminal elevator Inspection Division staff.

The Canadian International Grains Institute (CIGI), Winnipeg, Manitoba, continues to draw on the Research Laboratory for some of the resource personnel who participate in various Institute courses as lecturers or demonstrators. In addition, Drs. Kruger and Marchylo were part of a four-member CIGI technical mission which visited offices of the Chinese Import and Export Commodity Inspection in Beijing, Dalian and Shanghai in the People's Republic of China late in 1984 to obtain information for the development of a CIGI Grain Quality Control Technology Course. This course for a small group of Chinese cereal technologists began in the Institute in Winnipeg in late March 1985.

The Research Laboratory has been called upon to provide an increasing amount of technical service expertise to the Canadian Grain Commission and to the Canadian Wheat Board to aid in the sale of Canadian grain in both the domestic and the export market. Dr. LaBerge visited Brazil, Colombia and Mexico in January 1984 to discuss the quality of the 1983 crop with grain importers, maltsters, brewers and millers. Dr. Matsuo was a member of a three-man Canadian Grain Commission mission to France, Italy and The Netherlands to study grain handling, grain inspection and grading of both domestic and imported wheat and to assess the quality requirements for durum wheat, particularly with respect to the use of high temperature drying of pasta. Then following the 1984 harvest Dr. Tipples visited Japan, Hong Kong, Belgium, France, The Netherlands and the United Kingdom and Drs. Dexter and Matsuo visited South Korea, Taiwan, Indonesia, Sri Lanka, Malaysia and Singapore to discuss the quality of the 1984 crop of Canadian grains with importers, millers, bakers and other users.

Each year the Laboratory receives a substantial number of visitors from Canada and from many other parts of the world. These include scientists, technicians, representatives of the grain trade, producers and students. Several staff members were involved in conducting tours of the Laboratory for individuals and groups of visitors. During the 15-month period covered by the Report, 83 people from the following 23 countries (excluding Canada) visited the Laboratory: Argentina, Australia, Brazil, Cuba, Denmark, England, Ethiopia, Federal Republic of Germany, Finland, France, Ghana, Japan, Mexico, New Zealand, Nigeria, Norway, Pakistan, People's Republic of China, Peru, Portugal, Scotland, Sweden, Taiwan and the United States.

Five of these visitors spent considerable time in the Research Laboratory. Dr. Catherine Lenoir of the Centre National de la Recherche Scientifique, Meudon, France, was the recipient of a Visiting Fellowship from the National Science and Energy Research Council (NSERC) of Canada and spent the year 1984 in the Basic Barley Research section of the Laboratory investigating alpha-glucosidase enzymes in barley and malt. Her husband, Mr. Pierangelo Lenoir, also of the CNRS, Meudon, France, spent about nine months in the same Section studying debranching enzymes in barley and malt as part of his Ph.D. thesis project. Miss Carmen Jacinto Hernandez of the Laboratorio Central de Oleaginosas del Instituto Nacional de Investigaciones Agricolas, Chapingo, Mexico, spent the last six months of 1984 in the Oilseeds Section of the Laboratory under a Canada-Mexico Exchange Training Program, studying in detail all of the procedures used in the quality evaluation of oilseed crops. Dr. Elizabeth MacGregor of the Department of Chemistry, University of Manitoba, in January 1985 began a six-month (sabbatical leave) study in the Basic Barley Research Section studying cereal alpha-amylases. Also in January 1985 Dr. Martin Scanlon, a recent graduate of Leeds University, England, began a year of study in the Milling Section as a NSERC Visiting Fellow, examining implications of grinding on flour quality.

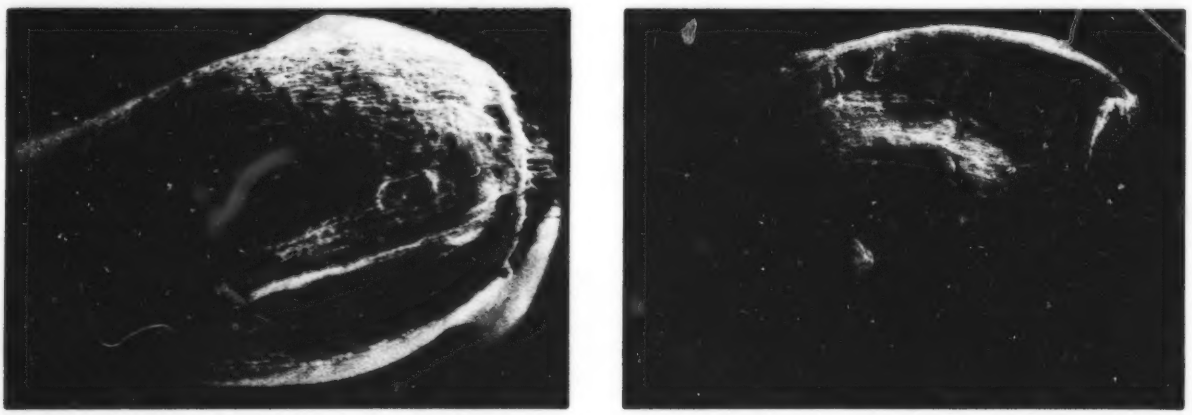
The staff of the Grain Research Laboratory totalled 91 at March 31, 1985. Thirteen casual assistants were employed for varying periods of time in the research, service, office and data processing sections of the Laboratory. As well, three university students worked in research sections of the Laboratory under the Federal Government's Career Oriented Summer Employment Program. There were two resignations from the permanent technical staff during the year and two additions to the professional staff.

RESEARCH

The research of the Grain Research Laboratory focuses generally on the question of what constitutes quality in grain and how quality is measured. For the most part quality is operationally defined by how well the grain performs in those processes that are involved in the production of particular end-products. For red spring wheat, the emphasis is on milling and the production of a variety of baked goods. For amber durum wheat, the primary usage is for pasta; accordingly studies involving milling and various aspects of pasta production are of major interest. In its work on barley, laboratory research concentrates on varieties suitable for malting as opposed to those used for feed purposes. Changes that take place in the constituents of barley during malting are major research subjects. The edible oil crop canola is the subject of the majority of the Laboratory's oilseed research. Mycotoxins and pesticide residues are the remaining areas of Laboratory research.

COMMON WHEAT

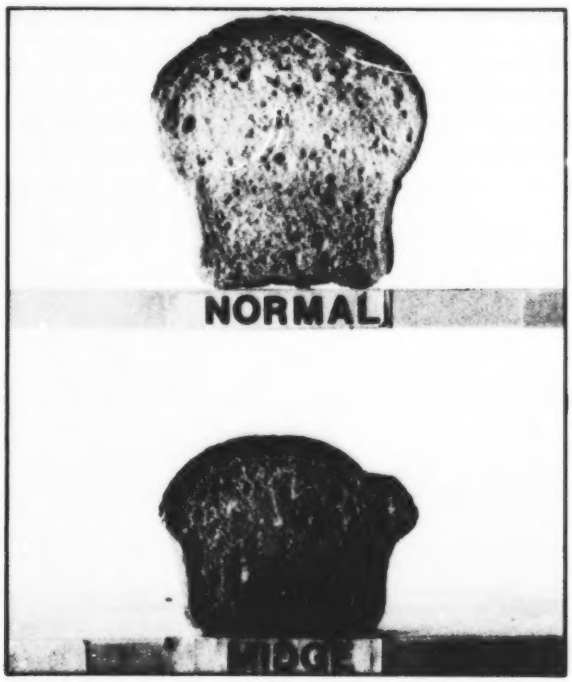
The effect of midge damage on the quality of red spring wheat. *The wheat midge is a tiny fly-like insect, somewhat smaller than a mosquito, that is found in many countries of the world. It was first observed in North America in 1828 and was reported in Eastern Canada in 1829. It was found in Manitoba in 1954 and produced considerable damage in Canadian wheat in the middle 1950's. It was found again in Canadian red spring wheat in localized areas in northwest Manitoba and northeast Saskatchewan in 1983 and in 1984. Both the adult midge and the larva are orange colored. The larvae of the wheat midge feed on the developing kernels in the wheat head by sucking out the sap. One larva feeding on a kernel results in shrivelled or shrunken grain. If several larvae feed, the kernels may be completely destroyed. Midge-damaged kernels have a reduced germination capacity, and poor milling and baking quality. Loaves of bread made from flour milled from midge-damaged wheat are markedly smaller than loaves made from sound undamaged wheat.*



Scanning electron micrographs of whole (left) and midge-damaged (right) wheat kernels showing shrunken endosperm, ruptured bran and sprouted embryo.

Most published reports on wheat midge epidemics are concerned with the strong negative effect on yield. The few reports in the literature describing the effect of midge damage on baking quality are not in agreement either on the cause or the extent of quality deterioration. A study was initiated in the Research Laboratory at the request of the Grain Inspection Division to determine whether the tolerances for insect-damaged kernels in the various grades of red spring wheat as specified in the grade schedule are consistent with the actual milling and baking potential of midge-damaged wheat. Preliminary results on samples of the 1983 crop showed that midge damage drastically altered baking performance, reducing baking absorption by as much as 10% and loaf volume by as much as 50%. The reduction in baking performance was quite variable and was not well correlated to the extent of midge damage as estimated visually.

Dough from midge-damaged flour exhibited a rapid softening subsequent to mixing, perhaps the result of enzyme activity. However, studies of alpha-amylase activity in midge-damaged and undamaged kernels indicate that midge damage *per se* does not contribute to increased amylase activity. Studies are continuing to determine the extent of midge damage to the 1984 crop and to determine the cause of the poor baking quality of midge-damaged wheat flour. The visible characteristics of midge larvae damage in red spring wheat have been studied in detail. Also midge-damaged amber durum wheat, rye and triticale have been studied and photographed.



Test loaves baked with flour milled from both normal and midge-damaged wheat.

Milling of hard red spring wheat naturally contaminated with deoxynivalenol (vomitoxin). *Deoxynivalenol (DON, also called vomitoxin) is one of the possible products of the infection of cereal grains by certain fungi (Fusarium graminearum). DON is known to be harmful to some (non-ruminant) animals; it may also be harmful to humans. Because of this possibility, when DON was identified on red spring wheat grown in Eastern Canada, studies were initiated to determine what happens to DON in wheat during both the milling of wheat into flour and the baking of flour into bread.*

In order to assess for regulatory purposes the possible human intake of DON from wheat, the effects of red spring wheat processing on DON distribution in milling fractions and its retention in baked products were investigated in the Research Laboratory in collaboration with Health and Welfare Canada and the Canadian International Grains Institute (CIGI). Two hard red spring wheats naturally contaminated with DON at 7.5 micrograms/g and 1.4 micrograms/g were subjected to cleaning, tempering and scouring processes and were then milled in the Grain Research Laboratory pilot mill; the low level wheat was also milled in the Allis-Chalmers experimental mill and the CIGI commercial-scale pilot mill. Flours were baked into bread and, in some cases, cookies and doughnuts. No appreciable losses of DON occurred during the cleaning, milling or baking processes. Some fractionation took place during milling: up to two-fold increases in DON concentrations were observed in shorts and feed flour fractions, while lesser increases were found in the bran from the wheat with the lower level (none for bran from the other wheat); there was some correlation of ash concentration with DON levels in the flour streams from GRL pilot milling of the two wheats.

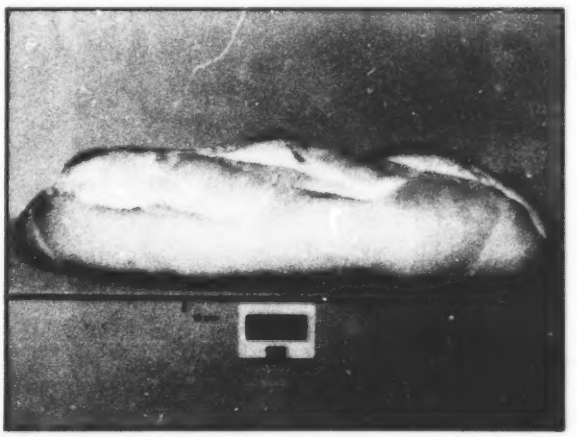
The objective of the milling of wheat is to separate the outer branny layers of kernels of wheat along with the germ portion from the central endosperm portion as efficiently as possible and then to break down gradually the endosperm material into particles of progressively smaller size. Wheats differ in their response on the mill to this process of gradual reduction in particle size. The starch portion of the endosperm is the major component involved. Starch is present in the form of essentially spherical granules. During the process of the gradual reduction in size of endosperm material, as a result of successive passes between pairs of mill rolls, most of the starch granules retain their spherical shape but a small proportion may develop cracks or fissures in their surface or may even have small fragments broken off. This is known as starch damage. Some varieties are more prone than others to the damaging of their starch. The presence of damaged starch alters the performance of the flour in physical dough tests and in the making of baked goods.

Grain Research Laboratory experimental mill.

The effect of pre-break conditions on wheat flour quality and power consumption during milling. The effect of pre-break conditions (break release, smooth vs corrugated rolls, roll differential) on milling yield and flour properties of Western Canadian red spring wheat, red winter wheat and HY320 is being examined using the experimental mill with 10" diameter rolls. Results to date indicate that flour ash improves when a pre-break is incorporated into the mill flow. Smooth rolls appear to be more effective than corrugated rolls in improving flour quality. Smooth pre-break rolls tend to impart a cleaner separation of bran from endosperm as reflected by a higher yield of broad bran and a lower yield of shorts. Using a pre-break did not appear to result in significant saving of power during milling.

Effects of inherent flour strength and starch damage on alveograph properties. Three wheat cultivars with differences in inherent flour strength (Benito, BW15 and Glenlea) were each milled by a variety of techniques to produce a wide range of starch damage. The alveograph properties of the flours were significantly correlated to both inherent flour strength (varietal effect) and starch damage. An analysis of variance demonstrated that for the sample set chosen, starch damage had a much greater impact on alveograph properties than inherent flour strength.

Relationship of flour starch damage and flour protein to the quality of Brazilian style hearth bread and remix pan bread produced from hard red spring wheat. Five commercial samples of No. 1 Canada Western red spring wheat varying in protein content were each milled, at constant flour extraction, to produce four levels of starch damage. Flours were baked into Brazilian style hearth bread using a short straight dough process and into pan bread using the GRL remix process. Hearth bread quality deteriorated as starch damage increased. The adverse effect of starch damage on hearth bread quality could be explained on the basis of flour water absorption requirements and related physical dough properties assessed by the farinograph and alveograph.



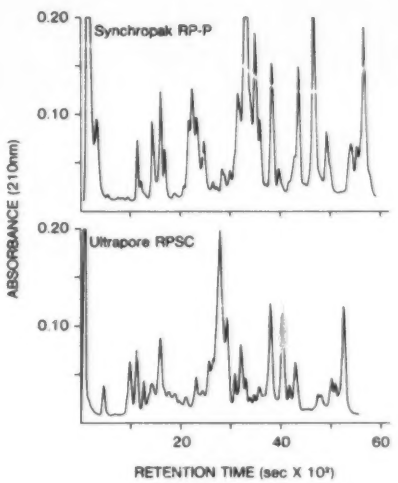
Brazilian-style hearth bread.

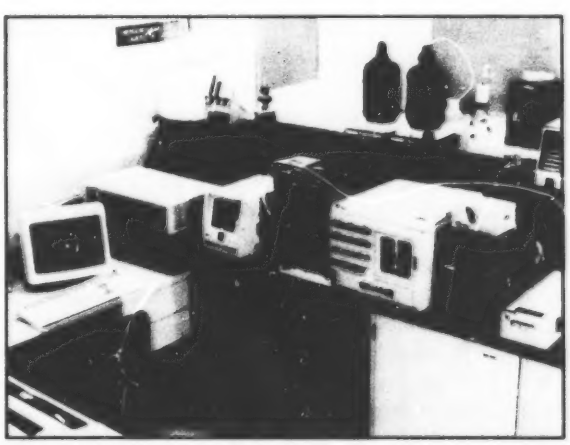
Collaborative study on testing wheat for hardness by near-infrared reflectance. *Hardness in wheat is considered to be an important milling quality characteristic because it influences the way in which the wheat performs during milling. As one example, hard wheats produce flour with higher levels of starch damage than do soft wheats. The Research Laboratory has carried out studies using near-infrared reflectance in an attempt to measure wheat hardness.*

A collaborative study cited in the 1983 Report had confirmed the feasibility of the grinding/sieving, Particle Size Index (PSI) method for testing wheat for hardness, simultaneously with protein and moisture. A further collaborative study has been carried out. Four models of NIR instruments were calibrated for hardness as determined by a PSI test. One hundred twenty-seven samples of wheat from the U.S., Canada, Australia, South America and Europe were employed. These samples were ground in the Grain Research Laboratory on three different grinders, and the final calibrations were all based on 381 samples. The constants were sent to 24 collaborators in the U.S. and Canada, together with 10 samples with a range of hardness, to verify the calibrations and make slope/bias adjustments where necessary, and 20 test samples. Collaborators were requested to return all test results, including optical data, together with their ground samples. Evaluation of the data to date revealed an average overall coefficient of correlation of 0.978 between NIR and PSI hardness data, and a mean standard deviation of differences between NIR and PSI hardness data of 2.6, for a coefficient of variability of 4.4%. It was concluded that the NIR method is suitable for rapid identification of wheat on the basis of hardness, and that the particle size index method can serve as the reference method. As in the collaborative study using the KT-30 grinder, the present study revealed significant differences in particle size characteristics between the 21 Cyclone grinders involved. These differences could be resolved, in terms of NIR hardness, by slope-bias corrections during calibration.

Soft white spring wheat quality evaluation. The methods used to evaluate quality in soft white spring wheat were consolidated. Early generation material is tested for protein content, kernel size, kernel hardness and dough strength by the wheatmeal fermentation time test (WMFT). The WMFT times are approximately transformed to a constant protein basis using four check varieties grown in five locations as the basis for the transformation. Genotypes with WMFT of over 25 minutes are considered too strong for the cookie- and cake-type flours. Stronger SWS types are suitable for Arabic-type two-layered flat bread baking.

High-performance liquid chromatography (HPLC) is a most elegant technique for the separation and identification of chemical constituents of cereals and oilseeds. The technique is being applied in the Research Laboratory to the proteins of cereal grains. The information derived for an individual cereal variety may be considered analogous to a fingerprint in humans; it appears in most cases to be a unique identifier of a particular variety. The technique offers promise as a chemical means of variety identification and accordingly may serve as a back-up to the visual identification of cereal varieties by grain inspectors as part of the grading of Canadian red spring wheats, amber durum wheats and barleys.





High performance liquid chromatograph with computer support for instrument control, data acquisition and manipulation.

Selection of column and operating conditions for reversed-phase high-performance liquid chromatography of proteins in Canadian wheat. Chromatographic conditions were optimized and three commercially available columns were evaluated for separation of alcohol-soluble storage proteins of Neepawa wheat using reversed-phase high-performance liquid chromatography (RP-HPLC). Optimal separation was achieved using an extracting solution of 50% 1-propanol, 1% acetic acid, and 4% dithiothreitol and an HPLC elution time of 105 min. at a flow rate of 1.0 mL/min. HPLC columns evaluated (Syn-Chropak RP-P, Ultrapore RPSC and Aquapore RP-300) varied in selectivity and resolution. The column providing the greatest versatility was Aquapore RP-300 available in cartridge form. Sodium dodecyl sulfate gradient gel electrophoresis analysis of protein peaks resolved by RP-HPLC indicated that many of the eluted peaks contained more than one protein species. Chromatographic protein patterns obtained for Neepawa wheat grown at different locations and in different years were qualitatively the same.

Examination of the mobilization of storage proteins of wheat during germination by high-performance reversed-phase and gel permeation chromatography. HPLC in the gel permeation and reversed-phase modes were used to monitor changes in storage proteins of five wheat cultivars during germination. In the gel permeation mode, 0.1M sodium phosphate buffer pH 7.0, containing 2% SDS was used as extractant and buffer solvent. Minimal changes occurred in the extractable storage proteins and the major observable change was the formation of low molecular weight species. In the reversed phase mode, proteins extractable with 50% 1-propanol, 1% acetic acid, 4% dithio- threitol had identical protein patterns on an Ultra-pore RPSC column at any stage of germination. This indicates that proteolytic degradation of storage proteins must be extremely rapid. The similarity of chromatographic profiles from sound and germinated wheat extracts in the reversed-phase mode suggested that the presence of sprout-damaged wheat would not complicate cultivar identification using this technique.

Rapid analyses of changes in the molecular weight distribution of buffer-soluble proteins during germination of wheat. A high performance liquid chromatography system, equipped with Spherogel-TSK 3000 aqueous size exclusion column, and a computing integrator with a molecular weight program, was used to monitor changes in buffer-soluble wheat protein components during germination of wheat kernels. At least 7 major components were present. During germination, small molecular weight entities were progressively formed from proteins; some bind to the column, and have longer column elution times than expected on the basis of their molecular weights. Such changes can indicate the approximate degree of germination of wheat kernels. Molecular weight profiles of extracts changed upon standing, indicating the presence of proteolytic enzymes. Cultivar differences in chromatographic elution profiles were very small.

Sprouting of grain, either standing or lying in the swath, which occurs during periods of prolonged wet weather, seriously reduces the quality. This is largely the result of the development of enzymes, particularly alpha-amylase. Alpha-amylase attacks or breaks down the very large carbohydrate molecules of which starch is composed. Excess levels of alpha-amylase can cause serious problems in baking due to dough softening and product deterioration.

A comparison of the catalysis of starch components by isoenzymes from the two major groups of germinated wheat alpha-amylase. Alpha-amylase isoenzymes from the two major groups (GI and GIII) present in germinated wheat were separated and purified by a two-step process consisting of affinity chromatography and chromatofocusing. The two groups, at equivalent enzymic activities, then were compared for their ability to hydrolyze a variety of starch substrates. No signiciant differences were found in the catalytic hydrolysis of beta-limit dextrin, amylopectin or amylose, as indicated by product distributions evaluated by high-performance aqueous gel permeation chromatography. At 37°C only the GIII group adsorbed on to large and small granules. Both groups, however, were able to solubilize starch with small granules being degraded faster than large granules. At 2°C the adsorption characteristics onto starch granules were identical for both groups. The GI and GIII isoenzymes had identical effects in lowering the amylograph viscosity of a wheat flour and in increasing its gassing power, suggesting that the action pattern of the two groups must be very similar.

AMBER DURUM WHEAT

The prime use of amber durum wheat is for the preparation of pasta products. Accordingly tests to evaluate the end-use quality of durum wheat are in large part related to pasta production. Durum wheats are milled not to produce flour, but rather to produce a somewhat more coarse product, semolina. For pasta production, semolina is mixed with water to give a very stiff dough; the dough is subsequently extruded under pressure to yield pasta of a variety of shapes. The pasta is then generally dried so that it may be packaged and stored conveniently. Traditionally pasta products were dried at a relatively low temperature of about 55°C. More recently however industry has adopted a considerably higher temperature, up to 85°C, for the drying of pasta. Research on durum wheat ranges from studies of the milling performance of the wheat itself, to pasta production, and to the cooking quality of pasta.

The relationship between durum wheat test weight and kernel size on semolina milling yield. The minimum test weight requirements for the grades of Western Canadian amber durum wheat are higher than for corresponding grades of red spring wheat. Many researchers have shown that test weight is at best a poor prediction of wheat milling yield. Some workers have suggested that kernel weight and kernel size distribution are more useful than test weight as predictors of wheat milling yield.

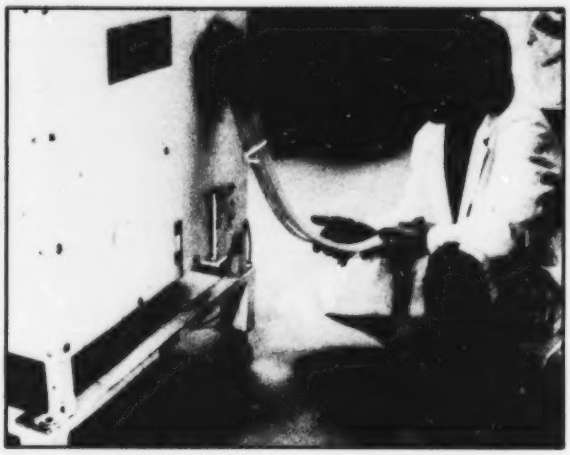
The 1984 Canadian amber durum wheat crop was ideal for investigating the relationship between test weight, kernel size and semolina milling performance exclusive of other grading factors. A great many samples that otherwise would have graded No. 1 CWAD were downgraded because of low test weight. Accordingly over 1000 samples from the Research Laboratory's 1984 new-crop amber durum wheat survey that visually graded No. 1 CWAD were segregated and composited on the basis of sample density to yield 50 samples ranging in test weight from 74 kg/hL to 83 kg/hL. The Grain Inspection Division confirmed that all samples visually qualify for No. 1 CWAD, although on the basis of test weight some were downgraded to No. 4 CWAD. Samples are currently being milled into semolina in duplicate, and milling performance will be related to test weight, kernel weight and kernel size distribution.

The relationship between kernel starchiness, kernel hardness and semolina milling yield for amber durum wheat. It is well established that starchy kernels of durum wheat tend to be softer than vitreous durum wheat kernels. Starchy durum wheat samples tend to give lower semolina yields with a greater proportion of fine material, and higher flour yields.

Currently the Grain Inspection Division of the Canadian Grain Commission defines a starchy kernel as one that shows even the slightest indication of starchiness. It seems likely that partly starchy kernels are harder than fully starchy kernels, making visual estimates of hard vitreous kernels (HVK) of limited usefulness in predicting grain hardness. A more useful prediction of semolina yield would be a direct hardness test such as the particle size index (PSI) test.

The relationship between kernel starchiness, kernel hardness, kernel structure and semolina milling performance is currently being investigated using 300 samples from the 1984 amber durum wheat new-crop survey. HVK counts were performed on each sample by the Grain Inspection Division and samples are now being analyzed for hardness by PSI and NIRS. Results to date show that the samples exhibit a wide range in hardness, but hardness is not related to HVK. Samples will eventually be pooled according to hardness and milled to determine whether semolina yield can be predicted on the basis of kernel hardness. The relationship between degree of starchiness and kernel hardness, kernel microstructure and semolina yield for handpicked samples will also be investigated.

The role of lipids in spaghetti stickiness. The study reported among last year's research projects has been completed. Surface stickiness of cooked spaghetti increased when hexane-extractable lipids were removed from the semolina. However, adding additional lipids to the control semolina did not decrease stickiness in every case; significant differences were noted in some instances but in others differences were statistically insignificant. There appeared to be no relationship between lipid content and stickiness of spaghetti processed from 10 cultivars of the Canadian durum wheat breeding program. However, the same 10 cultivars milled the second time with higher lipid content all exhibited lower stickiness. A commercial sample of No. 1 CWAD was milled to two levels of extraction 60.2% and 68.7%. The high extraction semolina with higher lipid content was less sticky than the low extraction, low lipid semolina.



Extrusion of spaghetti from laboratory-scale equipment.

BARLEY

Malting is the process in which kernels of grain, generally barley, are allowed to germinate for a limited time under carefully controlled conditions. The changes that take place within grain kernels during malting are referred to as modification. Malting conditions permit the initial seed growth processes to proceed only to a fixed limited extent. Chemical and biochemical changes occur within each seed. Outwardly, the germ begins to grow. More important, however, is the development of a variety of enzymes within the kernel. These begin immediately to act on other kernel constituents, principally endosperm storage material. Some of these enzymes degrade, or break down, the very large starch molecules. The break down products in malt are further broken down during brewing to yield primarily alcohol and carbon dioxide.

A high molecular weight constituent of the endosperm of barley is beta-glucan. Beta-glucans tend to be a problem in malting barley because of their ability to bind large amounts of water. If they persist through the malting and brewing processes, they create filtration problems. It is desirable then to be able to identify barley cultivars in terms of beta glucan content.

Barley endosperm modification during malting. Kernels of Bonanza barley, malted for different periods of time, were embedded in plastic, sectioned, stained and examined by light and fluorescence microscopy. The pattern of starch and protein degradation was similar to that observed by scanning electron microscopy and reported previously. Beta-glucan degradation was detected after 48 hours of steeping in endosperm areas close to the embryo and under the aleurone close to the embryo. After one day of germination, clearly visible degradation of beta-glucan had occurred under the aleurone at both the ventral and dorsal edges of the kernels. These results confirm findings from other laboratories that, although some beta-glucanase may be excreted from the embryo, large amounts of the enzyme are excreted rapidly from barley aleurone cells during early stages of germination.

Amylases play an important role in barley and malt quality. There are two major kinds of amylases in malted barley - alpha and beta. The two are distinguished by the differences in the way in which they break down starch molecules.

Production of alpha-amylases in germinating whole and incubating de-embryonated barley kernels. Alpha-amylases produced in germinated barley and incubated de-embryonated barley kernels (*cv.* Bonanza), in the absence and presence of gibberellic acid (GA_3), were analyzed qualitatively by polyacrylamide gel isoelectric focusing (PAG-IEF) and quantitatively by chromatofocusing. Identical patterns of alpha-amylase components were obtained for both germinated barley and incubated de-embryonated barley kernels at each germination/incubation stage, in the absence or presence of GA_3. Total alpha-amylase increased rapidly in the germinating whole seed whereas in the incubating de-embryonated grain the alpha-amylase activity increase was much slower. Addition of exogenous GA_3 did not induce production of higher levels of

alpha-amylase in either the germinating whole or incubating de-embryonated barley kernel. Quantitative chromatofocusing analysis revealed that the proportion of alpha-amylase III to alpha-amylase II activity decreased linearly with germination time in the whole grain but remained constant in the incubating de-embryonated grain in the absence or presence of GA_3. The major proportion of alpha-amylase activity in the germinating whole grain and incubating de-embryonated grain was synthesized in the form of alpha-amylase II components. However, alpha-amylase I represented a larger proportion of the total alpha-amylase activity produced in the incubating de-embryonated grain, as compared to the germinating whole seed in the absence or presence of GA_3. These results suggest that embryo excision differentially affects production of alpha-amylase II as compared to alpha-amylase I.

Alpha-amylase inhibitor studies. Further experiments were carried out on the alpha-amylase II inhibitor purified from barley. Products from the alpha-amylase II catalyzed hydrolysis of amylose in the presence and absence of inhibitor were analyzed. The inhibitor slowed down the rate of amylose hydrolysis but did not appear to alter the action pattern of the enzyme. A similar experiment was carried out with starch granules but, in this case, the product profile was different in the presence of inhibitor. A larger proportion of small dextrins (G_1-G_4) and a correspondingly smaller proportion of intermediate dextrins (G_5-G_{14}) were found. These results suggest that the inhibitor is more effective in inhibiting starch granule hydrolysis than the further hydrolysis of initial products of granule degradation.

Hydrolysis of starch granules by amylases. Large and small starch granules from barley were hydrolyzed by alpha-amylases I and II from malt and the resulting products were analyzed by high performance thin layer chromatography. In agreement with previous results, small granules were hydrolyzed faster than large granules and alpha-amylase I hydrolyzed granules faster than did alpha-amylase II. The major hydrolytic products were small oligosaccharides (G_1-G_7) that were shown to be essentially linear by further enzymic analysis. Oligosaccharides larger than *ca.* G_{18} formed a significant proportion of the total soluble product and these were shown to be branched, *i.e.*, they consisted of linear chains of glucose units with small alpha 1-6 linked stubs. Preliminary analysis of the data suggests that significantly more glucose is produced during alpha-amylolysis of starch granules compared to hydrolysis of solubilized starch. In addition, small variations were detected in product distributions between alpha-amylase I and alpha-amylase II catalyzed reactions. These results may help to explain the formation of the heterogeneous mixture of oligosaccharides found during mashing and, subsequently, in beer.

Beta-amylase does not hydrolyze intact starch granules but there is conflicting evidence as to whether or not beta-amylase can attack damaged starch granules from cereal grains. Experiments were carried out using barley starch granules to determine a) if the addition of barley beta-amylase to starch granule alpha-amylase II digests increased the rate of starch solubilization and b) if beta-amylase could hydrolyze starch granules that had been degraded significantly by alpha-amylase II. No effect of beta-amylase was detected in either case.

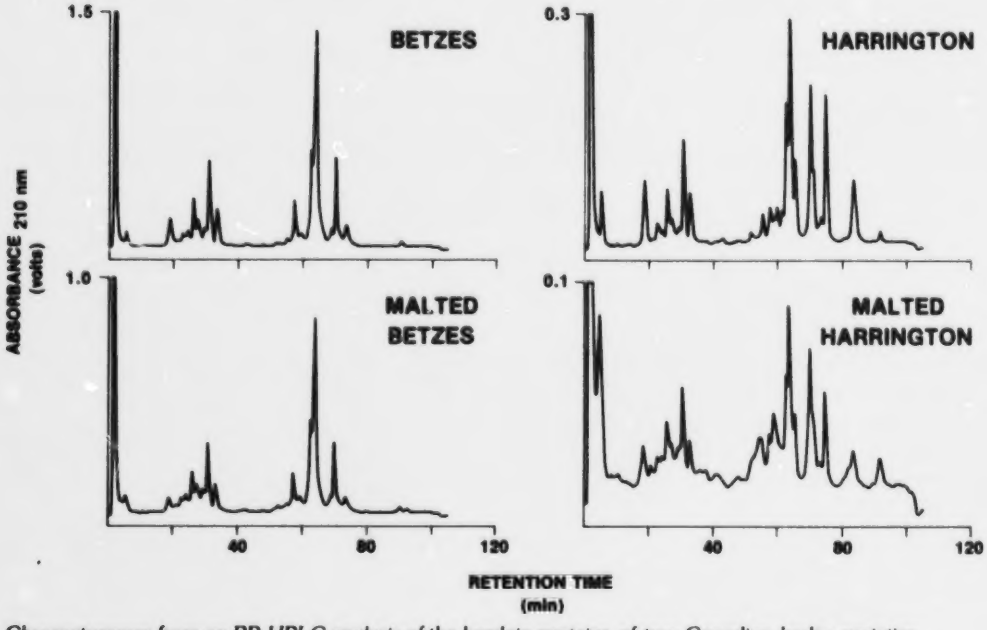
Focusing properties of beta-amylase enzymes. Studies of the chromatofocusing and isoelectric focusing characteristics of beta-amylase enzymes of thiol-containing extracts of barley and malt were continued in 1984. Some of the heterogeneity of beta-amylase components found in extracts of barley noted in previous research summaries was found to be due to changes occurring as freshly-prepared extracts age. Two cultivars, Bonanza and Ellice, were investigated by focusing techniques from floral anthesis to harvest ripeness. Interestingly, beta-amylase isozymes were detected in immature kernels with apparent pI values identical to beta-amylase enzymes that appear when barley is malted.

Other cereal grains were investigated for focusing properties of beta-amylase enzymes. These included four cultivars of hard red spring wheat, two durum wheat cultivars, two rye cultivars and one cultivar each of soft white spring wheat and triticale. As in the case with sound barley, each of these cereals produced complex focusing patterns with many isozymes with distinctive apparent pI values.

Barley beta-glucan study. In collaboration with Prof. M. Ballance of the University of Manitoba a study was carried out to determine optimum conditions for the determination of total beta-glucan content of barley. Thirty-three samples of different genotypes and cultivars of barley were used to optimize mathematical treatments and wavelengths for the determination of total beta-glucan, using a Pacific Scientific Model 6250 Research Composition Analyzer. Range in total beta-glucan was from 2.80 to 6.62% in the samples used for verification. The samples were scanned between 100 and 2500 nanometers. The log 1/R spectra indicated that large differences existed in the particle size characteristics of different varieties. This suggested significant differences in kernel hardness. The differences in particle size (as evaluated by the log 1/R values at 1680 and 1978 nm) were not closely related to beta-glucan content ($r = .46$ and -0.36 respectively), but may have been caused by differences in growing conditions. The genotypes R1S0 1508, R1S0 8 and SV70/.22338 had the highest log 1/R values, and Yugoslavian 13, and Colosses IAC the lowest values.

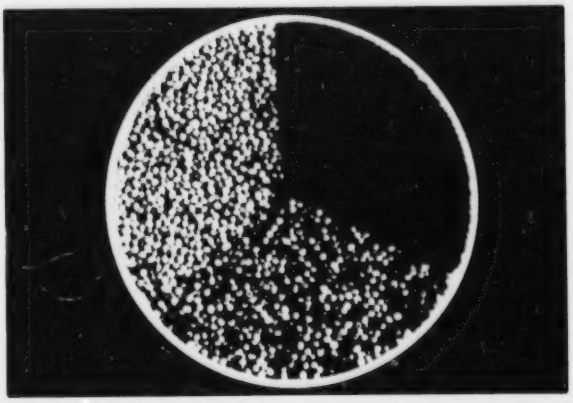
Fifty scans were run per sample, and the spectra were recorded at intervals of approximately 2 nanometers. The spectra represented the means of the 50 scans for each of the 700 data points. Wavelengths were selected using a formal stepwise multiple linear regression program, and the mathematical treatment and derivative size were optimized. Most accurate results were obtained using the second derivative of the log 1/R signal with smoothing over 5 data points, and a derivative size of 35 points (70 nm). The wavelength points selected were 1976, 1232, 1158 and 2148 nm using these dimensions for the derivative. Standard error of performance (SEP) was 0.32, mean deviation between chemical and NIR methods was -0.19% beta-glucan, and coefficient of correlation was 0.964.

Assessment of reversed-phase high-performance liquid chromatography columns for separation of hordein proteins and cultivar identification of barley and barley malt. Reversed-phase high-performance liquid chromatography (RP-HPLC) was used to resolve the hordein protein fraction of barleys and malts. Separations obtained by three RP-HPLC columns differing in size and/or alkyl chain length were studied. The effect of elution time and column temperature on resolution of the hordeins also was assessed. Resolution was comparable between columns but differences in selectivity were observed. The major differences between columns were related to speed of analysis and versatility. Computer analysis of chromatograms was used to assist in the identification of cultivars. Analysis of 22 Canadian barley cultivars and 10 cultivars of barley malt revealed that the majority were distinguishable. RP-HPLC, therefore, appears to have considerable potential to serve as a barley and malt cultivar identification technique.



Chromatograms from an RP-HPLC analysis of the hordein proteins of two Canadian barley varieties.

Quality characteristics associated with the seed coat color of Canola. *The normal color of the seed coat of rapeseed grown commercially in Canada over the years has been dark, ranging from a reddish-brown to black. However, Canadian plant breeders have, in recent years, developed some new* (Brassica Campestris) *varieties in which the color of the coat of individual seeds ranges from yellow to dark. A study is underway to determine the relationship between seed coat color and the quality characteristics of the two partially yellow-seeded rapeseed cultivars, Tobin and Candle. These two rapeseed cultivars are classed as canola because of their sufficiently low levels of a specific component of the oil (erucic acid) and of components of the seed solids known as glucosinolates.*



Samples of the *Brassica Campestris* cultivars, Tobin and Candle, selected for this study included breeders' seed, certified seed, and commercially grown seed. The percentage of yellow-coated seeds in the original samples was determined by replicated hand separations.

The percentage of yellow-coated seeds in the breeders' seed samples ranged from 65-85%, compared with 75% in certified seed samples. Commercially grown new crop material contained only 50-65% of yellow-coated seeds, suggesting some volunteer growth of black-seeded varieties may have occurred.

The yellow-coated seeds from breeders' and certified seed samples are, in the results to date, equal to or higher in oil content and protein content than the dark seeds. The original, unseparated samples had oil content and protein content values proportional to their constituent percentage of yellow and dark seeds. Quality differences between the yellow and dark seed fractions of five commercially grown samples were smaller than those in the breeders' and certified seed samples; the dark seeds are slightly higher in oil content than the yellow seeds while the protein content is the same in the yellow and dark fractions. Erucic acid content is higher in the dark fractions of all samples examined. The overall higher erucic values in the survey material again suggests volunteering of older cultivars. Analysis of the fibre content of these materials is planned.

Composition of crushing plant seed, meal and oil. Some years ago the Oilseed section of the Research Laboratory instituted a program to survey, on a monthly basis, the Canadian rapeseed crushing industry. Participating plants in Ontario, Manitoba, Saskatchewan and Alberta provide a sample of their seed stock, and of the resulting oil and the residual meal. Results of the Laboratory's detailed analyses of the samples are reported in coded form to all participants. This program has enabled the Laboratory to keep in close touch with the oilseed industry.

This review covers results of this survey of seed, oil and meal from five commercial rapeseed crushing plants for a 30 month period from 1982 to 1984. The glucosinolate content of the seed decreases during the crushing operations resulting in lower glucosinolate levels in the residual meal than in the original seed. This decrease varied from crusher to crusher, and ranged from a low of 30% to a high of 90%. The level of the indolylglucosinolates was reduced more by processing than was that of the alkenylglucosinolates. Oil sulfur values were typically less than 5 ppm with occasional values near 10 ppm. Oil sulfur levels during the period of this survey were lower than those observed during the previous two years in this survey. This probably reflects improved processing techniques in the industry along with an increased proportion in the crop of cultivars of lower glucosinolate content. The moisture and protein content of the meals were dependent on the seed and ensuing processing conditions. Plant means for meal moisture ranged from 8.79-10.0%, while means for protein were from 39.1-45.8%. Meal residual oil content also tended to be characteristic of the crushing plant with means from 2.00-3.88%.

The mean value, by crushing plant, for meal moisture content ranged from 8.3-10.0% while the mean value for protein content ranged from 39.1-45.8%. The residual oil content of the rapeseed meal also tended to be characteristic of the crushing plant, the mean value ranged from 2.00 to 3.88%.

Chlorophyll in rapeseed. *Chlorophyll, the green coloring matter in the leaves of plants, enables the plant, when exposed to light, to manufacture carbohydrates from carbon dioxide in the air and water. In rapeseed, the presence of chlorophyll and related pigments in the seed tends to make the processing of the rapeseed oil difficult. For this reason, there is interest in determining the conditions during the growth of the rapeseed plant which affect the amount of chlorophyll incorporated into the seed and also in studying how the amount of chlorophyll present in the seed affects commercial oil recovery. Such information is necessary to ensure that the tolerances for distinctly green seeds in the various grades of Canadian rapeseed accurately reflect the utility of rapeseed in the commercial, domestic and foreign crushing industry.*

In a continuing project on rapeseed chlorophyll, four Dickey-john GAC III Grain Analysis Computers were modified by replacing two of the UV-range "oil filters" with visible-range filters. The modified instruments were then calibrated for the determination of rapeseed chlorophyll using about 100 samples. The modified instruments are capable of determining chlorophyll in ground rapeseed in the range of from 2 to 60 ppm. This covers the range of chlorophyll levels encountered in the various grades of Canadian rapeseed under the existing tolerances for distinctly green seeds. The error in the determination of chlorophyll in rapeseed using this new infrared reflectance technique is about 1 ppm.

These four Dickey-john GAC III instruments were sent from the Laboratory to Grain Inspection Division offices in terminal elevators in Vancouver. There the units are being operated by Commission Grain Inspection staff under normal operating conditions in terminals. This study is designed to determine whether this technique is a practical efficient addition to the grading procedures for rapeseed export.

Chlorophyll in canola oil. Chlorophyll and chlorophyll-derived pigments are the cause of major problems in the commercial extraction and processing of oil. Accurate measurement of the levels of these components in canola oil is difficult and. even though some work was carried out in Canada several years ago to develop a suitable procedure, no standard method yet exists. The Oilseeds section of the Grain Research Laboratory organized a study of the determination of chlorophyll in rapeseed oil in which 12 laboratories participated. The object of the study was to try to establish a standard set of test conditions for this determination.

A round-robin study of chlorophyll determination was organized by the Research Laboratory in which three samples of canola oil containing 10, 25 and 50 ppm chlorophyll were circulated and analyzed in 12 different laboratories. There was a very wide range in results — indicating a need for a standardized procedure for chlorophyll determination. Each participant used a spectrophotometric procedure but there was a wide variation in analytical parameters - the spectrophotometer itself, wavelength used, solvent, dilution factor, and calibration factor. The study pointed out the need for agreement on a definition of chlorophyll concentration in ppm. Some laboratories report results on weight basis, *i.e.*, micrograms/g while others report on a volume basis, *i.e.*, mg/L. Canola oil has a density of 0.92 (approximately), accordingly results expressed by the two methods will differ by almost 10%.

As a consequence of this study, the Oilseed Section of the Research Laboratory is developing a spectrophotometric procedure for the determination of chlorophyll in canola oil that is easy, reliable and precise. When a satisfactory procedure has been devised, the round-robin test will be repeated in the hope that the oilseed industry will adopt it as a standard procedure.

RESIDUE ANALYSIS

Increasing use is being made in agriculture today of a wide variety of chemicals for seed treatment, weed control and insect control. To ensure freedom from residues of these chemicals in grain entering food channels involves rather elaborate monitoring techniques. The Research Laboratory maintains a program to monitor Canadian grains and oilseeds for the presence of residues of pesticides and herbicides. Now added to this program is a monitoring for residues of toxic materials produced by fungal infestation of grain.

Degradation of malathion and pirimiphos-methyl on stored rapeseed. In collaboration with Dr. N.D.G. White of the Agriculture Canada Research Station, Winnipeg, a study was initiated to investigate the persistence on stored rapeseed of pirimiphos-methyl relative to that of malathion. At present, malathion is the only grain protection insecticide licensed in Canada for use on cereal grains. There are no grain protectants licensed for use on rapeseed. Pirimiphos-methyl is gaining world-wide acceptance as a grain protectant for cereals and to a lesser degree for oilseeds. In order to study the degradation of malathion and pirimiphos-methyl on rapeseed, samples of two different varieties were treated at a level of 8 ppm and then stored under varying conditions of temperature and humidity for a period of up to 32 weeks. Residue analysis of these samples is currently being carried out in the Grain Research Laboratory.

Pesticide residue analysis methodology. The analytical scope of the GRL pesticide residue screening methods for cereal grains and rapeseed has been expanded to include three synthetic pyrethroids; cypermethrin, deltamethrin and permethrin. This improvement was facilitated with use of an electron capture detector capillary gas chromatograph with multi-ramp temperature programming capability. With this system the synthetic pyrethroids can be determined along with the common organochlorine pesticides in a single gas chromatography run.

The Research Laboratory has acquired a Hewlett-Packard mass selective detector (MSD) capillary gas chromatograph for use in confirming suspected residues found in Canadian grain. This state-of-the-art system incorporates a powerful micro-computer for data acquisition and manipulation. Compounds are identified on the basis of their electron impact mass spectrometry results. The MSD system is currently being calibrated for many of the pesticides licensed for use on Canadian grain.

Capillary gas chromatograph equipped with a mass selective detector.

An analytical method was devised for determining methyl bromide residues on grain. The method involves soaking whole grain in ethyl acetate to desorb any methyl bromide residues that may be present. An aliquot of the extract is injected without cleanup into an electron capture detection gas chromatograph (ECD-GC). The ECD-GC is calibrated using gas injections of methyl bromide standards made up in nitrogen.

Mycotoxin residue analysis methodology. The Research Laboratory participated in a collaborative study of a gas chromatography method for determining vomitoxin in wheat. Vomitoxin is determined as the trisheptafluorobutyrate derivative which is prepared by derivatization with capillary column gas chromatography and mass selective detection with selected ion monitoring. Following this approach, the detection limit for vomitoxin appears to be at least 0.01 ppm.

QUALITY STUDIES ON CURRENT CROPS AND OTHER STUDIES

SECTION 2

Annual survey of the quality of Western Canadian grains and oilseeds. *The end-use quality characteristics of the 1984 crops of Western Canadian red spring wheat, amber durum wheat, barley, flaxseed, rapeseed and sunflower seed were assessed in the Research Laboratory's annual new-crop survey. Results of these studies were published as usual in a series of three red spring wheat protein maps and four crop bulletins. Titles of the publications are listed in Section 4 under the heading Periodical Publications.*

Protein content and quality of 1984-crop Western Canadian red winter wheat. The eighth annual harvest survey of the protein content and milling and baking quality of the new crop of Western Canadian red winter wheat was carried out in 1984 in co-operation with the Canadian Wheat Board. Western Canadian producers of red winter wheat, selected at random, were asked to submit a sample of their 1984 crop; 470 samples were received; 214 were from Alberta, 223 from Saskatchewan, and 33 from Manitoba. Of these, over 66% graded No. 1 Canada Western Red Winter (C.W.R.W.), over 17% graded No. 2 C.W.R.W., and nearly 16% graded No. 3 C.W.R.W. The protein content of the 1984 red winter wheat samples averaged 11.3% compared with 10.9% for the 1983 survey, and 11.0% for 1982. The protein content decreased with grade for the 1984 crop samples; No. 1 C.W.R.W. samples averaged 11.8%, the No. 2 C.W.R.W. samples 11.0%, and the No. 3 C.W.R.W. samples 9.3%.

Protein content and quality of 1984-crop Western Canadian soft white spring wheat. In another study in co-operation with the Canadian Wheat Board, the Laboratory estimated the protein content and the milling and baking quality of the 1984 crop of the soft white spring wheat variety Fielder. Producers growing Fielder under contract submitted a sample of their 1984 crop to the Canadian Grain Commission. The samples were screened and only one sample per grade from a producer was selected for the survey. Of the total of 1,314 samples selected, 88% were from Alberta. The protein content of the samples of the 1984 crop of soft white spring wheat averaged 10.9%, compared with the level of 11.0% and 10.6% for the 1983 and 1982 Fielder surveys. Over 70% of the 1984 crop samples graded No. 1 Canada Western Soft White Spring (C.W.S.W.S.), 28% graded No. 2 C.W.S.W.S., and 1%, No. 3 C.W.S.W.S. The protein content was essentially independent of grade. No. 1 C.W.S.W.S. wheat samples averaged 10.8%, No. 2 C.W.S.W.S. averaged 11.0% and No. 3 C.W.S.W.S., 10.9%.

Protein content and quality of 1984-crop Western Canadian HY320 red spring wheat. HY320 is a new cultivar of red spring wheat which has considerable promise in Western Canadian agriculture as the forerunner of a new class of wheats which has become known as "triple M". HY320, unlike the licensed varieties of red spring wheat, is of a "medium" level of wheat hardness, a "medium" level of protein content, and a "medium" level of strength in terms of its end-use characteristics. It was grown experimentally in 1984 under a Canadian Wheat Board program in which a selected number of producers contracted to seed 50 acres of HY320. At harvest, these producers submitted a sample of their 1984 crop of HY320 to the Canadian Grain Commission. A total of 2,850 samples of HY320 was received. All samples were analyzed individually for protein content. Then samples were bulked together by grade and protein content range. The bulk samples were subjected to detailed milling, analytical and end-use quality tests.

Almost 90% of the samples qualified for the grade No. 1 C.W. Experimental (now No. 1 Canada Prairie Spring), and these averaged 12.5% in protein content. Samples entering the grade No. 2 C.W. Experimental, 6.5% of the total, averaged 12.7% protein.

Protein content and quality of 1984-crop Eastern Canadian white winter wheat. The Research Laboratory's 1984 survey of the new crop of white winter wheat grown in southwestern Ontario was based upon 237 samples, from one or more locations in 25 counties. The protein content of the 1984 crop samples averaged 9.3%, compared with a level of 10.1% for the 1983 crop and an average of 10.2% for nine of the new crops during the 10-year period 1973-1982. (No samples of the 1981 crop were received in the Research Laboratory.)

Falling Number of 1984-crop Western Canadian rye. The Research Laboratory again conducted a survey of new-crop Western Canadian rye using the Falling Number test as an indicator of the level of alpha-amylase activity. The Laboratory received a total of 650 samples of 1984-crop rye:

146 were from Manitoba, 372 from Saskatchewan, and 132 from Alberta. Samples of the grades No. 1 and No. 2 Canada were composited by grade and crop district for each province, while samples of No. 3 Canada were composited by province only. The composites were subjected to the Falling Number test and mean values (weighted by estimates of production by crop district) were calculated to be 234 seconds for No. 1 Canada and 207 seconds for No. 2 Canada. The Falling Number for a prairie-wide unweighted composite of No. 3 Canada was 200 seconds.

Oil content and protein content of 1984-crop Eastern Canadian soybeans. The annual survey of the quality of the new crop of Eastern Canadian soybeans grown in southwestern Ontario was based upon 270 samples gathered and submitted to the Research Laboratory by the Ontario Soybean Growers Marketing Board, Chatham, Ontario. The Chatham office of the Grain Inspection Division of the Canadian Grain Commission graded the samples which represented 15 counties and regional municipalities. Just over 68% of the samples graded No. 1 Canada, 30% graded No. 2 Canada, and 2% No. 3 Canada. The oil content of the 1984-crop soybean samples of the grades No. 1 and No. 2 Canada averaged 20.3% (moisture-free basis) compared with the level of 21.1% for the 1983 crop and the 10-year average value of 20.6% for the crops from 1974 to 1983. The seed protein content for the samples of the 1984 soybean crop grades No. 1 and No. 2 averaged 41.2% (moisture-free, whole-seed basis) compared with the level of 41.5% for the 1983 crop, and the 10-year average value of 41.4%.

Oil content and protein content of 1984-crop Manitoba soybeans. In co-operation with the Manitoba Department of Agriculture, the Research Laboratory carried out its fourth annual survey of the quality of soybean hybrids suitable for growing in Manitoba. These hybrids have significantly lower heat requirements during the growing season. Representatives of the AGRO-MAN Soybean Project collected and submitted 47 new-crop samples. For the second consecutive year, the development and ripening of the new crop reflected the severe hot dry weather during the growing season, with all of the samples grading No. 2 Canada or lower. Maple Amber was the predominant variety, representing over 80%, of the samples in the survey. This variety averaged 23.0% in oil content (moisture-free basis), 0.2 percentage units lower than the 1983 level for the variety. The samples of Maple Amber averaged 37.6% in seed protein content in 1984, compared with the level of 37.3% in the 1983 crop.

Pesticide residue monitoring of export cargoes of wheat, barley, oats, rye and rapeseed. Canadian exports of wheat, barley, oats, rye and rapeseed are screened, in an ongoing program, for residues of common organochlorine, organophosphate and organonitrogen pesticide treatment chemicals. In the 1983-84 crop year, analyses were carried out on samples of 1,771 cargoes. Minor quantities of pesticides, mostly malathion, were detected in the occasional shipment. However, the amount of residue found was generally well below both international and Canadian tolerance levels.

A special survey was initiated by the Research Laboratory to verify the absence of ethylene dibromide (EDB) in Canadian cereal grain exports. During the 1983-84 crop year, samples of 157 cargoes were tested. Results for all but one were negative for EDB. This single sample had a residue level just above the detection limit of the analytical method, 5 ppb.

Monitoring for residues of pesticides used to control the wheat midge. A special survey was undertaken by the Research Laboratory, in co-operation with the Commission's Grain Inspection Division, to establish whether emergency spraying of pesticides to combat the wheat midge posed a residue hazard in wheat. The survey involved analysis of samples from 109 carlots of wheat shipped from 47 country points in the provinces of Manitoba and Saskatchewan. Samples were screened for residues of common organochlorine, organophosphate and organonitrogen pesticides with special attention to carbofuran, chlorpyrifos, dimethoate, permethrin and methoxyclor. Of these five insecticides, only chlorpyrifos was detected but in no case did the residue exceed 0.01 ppm.

Screening of wheat and corn shipments for mycotoxin residues. The Research Laboratory's newly established monitoring program to screen for residues of vomitoxin (deoxynivalenol) in exports of Canadian wheat involved analysis of samples of 239 cargoes in the 1983-84 crop year. Vomitoxin was detected in the occasional shipment of Eastern white winter wheat and Western Canadian soft white spring wheat, but in no case did the amount exceed 0.10 ppm. Vomitoxin was not detected in any export shipment of Western Canadian red spring wheat.

Exports of Canadian corn and red spring wheat shipped during the 1983-84 crop year, were monitored for residues of aflatoxin. A total of 36 corn cargoes and 142 wheat cargoes was analyzed. Aflatoxin was not detected in any shipment.

Supervision of moisture testing. The Grain Research Laboratory maintains a bi-weekly check test program to monitor the performance of all of the Model 919 grain moisture meters used by the Canadian Grain Commission in offices of its Grain Inspection Division in about 40 locations across Canada. Every two weeks, a bulk sample of red spring wheat is mechanically subdivided into sufficient homogeneous subsamples to provide one for each meter location within the Grain Commission. The moisture content obtained on each individual Inspection Division 919 moisture meter is submitted to the Laboratory and an average moisture content value is calculated for all meters for each individual check test. Meters giving results within ± 0.2 percentage units of the mean result are satisfactory.

Meters giving results which deviate from the mean result by more than ± 0.2 are brought into the Laboratory for checking, service and repair. Following repair, the performance of field meters is made to match that of Laboratory standard reference 919 moisture meters by carefully adjusting electronic components of the field units. Only then are meters returned to the Inspection offices.

A total of 125 Model 919 moisture meters equipped with 3.5-inch cells and 14 meters equipped with 3-inch cells was employed during 1984 in the various offices of the Grain Inspection Division. During the year, 26 sets of check test samples were used to monitor meter performance; 71 meters were recalled or returned for service and repair.

The head offices of the major grain firms operating primary elevators in Western Canada and several provincial government agriculture offices are also included in the bi-weekly check test. This is to help these organizations monitor for themselves the performance of their own moisture testing equipment.

Dividing a wheat sample into sub-portions for use in the GRL moisture meter check-test program.

Tests on the Kett Riceter Model L and PB-ID Moisture Tester. Two grain moisture testers, manufactured by Kett Electric Laboratory Co. Ltd., Japan, were examined recently in the Research Laboratory and their performance compared to that of the Model 919 moisture meter used for years in the Canadian Grain Commission for the determination of grain moisture. Two grains only, wheat and barley, were used in these tests.

Both of the Kett instruments operated on the principle of the measurement of electrical resistance and both are temperature compensated. Both meters are portable. The Model L meter is battery-powered while the PB-ID meter is either AC or battery powered. Both meters featured digital readout for the moisture content of wheat, barley and rice. Samples to be tested in the Model L meter are coarsely ground in a burr-type mill built into the unit. The test cell is then filled with ground grain and the test sample is then compressed (under a constant pressure) while the measurement is made. A standard cell with a fixed resistance is provided in order to check that the meter is properly adjusted. Samples to be tested in the PB-ID meter are coarsely ground in the instrument using a constant compression screw. The moisture result is displayed by pressing the button for the type of grain being tested. The PB-ID meter includes a battery check and an automatic averaging of from 2 to 9 individual moisture tests.

The Model L meter exhibited good reproducibility in tests on wheat and reasonably good reproducibility in tests on barley, particularly in the light of the very small sample size. The meter would require recalibration for use with Canadian wheat and barley.

The PB-ID meter exhibited very good reproducibility in tests on both wheat and barley. But the programmed calibrations for wheat and barley gave moisture results that were considerably lower than those obtained using the Model 919 meter. However a conversion chart provided specifically for Canadian wheat gave results that agreed well with those obtained using the Model 919 moisture meter.

VARIETY STUDIES

SECTION 3

An important part of the program of the Research Laboratory each year is the evaluation of the end-use quality of new cultivars of red spring wheat, amber durum wheat and malting barley. Results of this work are reported annually to the Expert Committee on Grain Quality which along with two sister committees on Grain Breeding and Grain Diseases carries out cultivar testing under the Canada Agriculture Services Co-ordinating Committee. New cultivars must meet certain minimum standards of agronomic performance, disease resistance and end-use quality in order to be licensed in Canada and made available to farmers for commercial production. In addition to the testing of cultivars developed by Canadian plant breeders, the quality evaluation program includes spring wheats and occasionally durum wheats and barleys developed in the United States, but which may be suitable for growing in Canada.

RED SPRING WHEAT VARIETIES

Varieties grown by Canadian plant breeders. The annual Co-operative Test is the vehicle within which new cultivars of red spring wheat are evaluated to determine whether, as required by the Canada Grain Act, they are equal in quality to Marquis. The Co-operative Test for red spring wheat comprises two regional tests. The Central Bread Wheat (CBW) Co-operative Test is for wheats developed particularly for the eastern half of the Western Canadian prairie growing area where rust resistance is a prime requirement. The Western Bread Wheat (WBW) Co-operative Test is for wheats developed for the western half of the Prairies where resistance to drought and to the sawfly along with early maturity are prime requirements.

Twenty-six cultivars of red spring wheat (14 in the WBW, 10 in the CBW, and 2 in both) plus 7 standard or reference varieties were grown in 1983 at 18 locations in Western Canada. There were 7 entries in the CBW test for the first time (11 from the Agriculture Canada Research Station, Winnipeg) and 8 in the WBW test (3 from the University of Saskatchewan and 5 from the Agriculture Canada Research Station, Swift Current). There were 8 entries in the tests for the second consecutive year, and one entry in for the third year. Composite samples of each cultivar were tested in the Research Laboratory early in 1984 to evaluate milling, baking and related end-use quality characteristics.

Varieties grown by United States plant breeders. The Research Laboratory again participated in an annual American collaborative study to evaluate the milling and baking performance of red spring wheats developed for the upper midwest region of the United States. This study was conducted by the Spring Wheat Quality Advisory Council of the United States (successor to the Crop Quality Council).

The current series of quality tests was carried out on five red spring wheat lines grown at up to four locations, one in Minnesota, two in North Dakota and one in South Dakota, in the summer of 1984. Two of the new cultivars were semi-dwarf, and three were of conventional height. The American red spring wheat Len was the control variety against which the quality of the new cultivars was judged.

AMBER DURUM WHEAT VARIETIES

Varieties grown by Canadian plant breeders. Fifteen new cultivars of amber durum wheat plus 5 standard or reference varieties were grown at 7 locations in Western Canada in the summer of 1983 in the annual Co-operative Test and were evaluated for their end-use quality characteristics in the Research Laboratory early in 1984. One cultivar was in the test for the fourth consecutive year, one cultivar was in the test for the third consecutive year, two cultivars for the second consecutive year, and eleven cultivars were in the test for the first time.

Milling, pasta-making and spaghetti-cooking tests were also carried out on 31 new amber durum wheat cultivars plus five check varieties grown in the 1983 Co-operative "B" Test. Cultivars exhibiting suitable quality characteristics are introduced by the plant breeders into the annual Durum Wheat Co-operative Test.

BARLEY VARIETIES

Varieties grown in the annual barley Co-operative Tests. New cultivars of barley developed by plant breeders are grown annually in two regional tests to identify barleys that are equal in quality to the statutory standard, Bonanza or Klages, specified in the Canada Grain Act. These two tests are the Western Co-operative Six-Row Barley Test and the Western Co-operative Two-Row Barley Test. In 1983, the Western Co-operative Six-Row Barley Test included 33 new entries and 3 check cultivars grown at 11 locations in the 3 Prairie Provinces. Twelve entries (11 first year entries, and the check cultivar, Bonanza) from 3 locations were malted at the Agriculture Canada Winnipeg Research Station and malt analyses were performed jointly at the Winnipeg Research Station and Grain Research Laboratory. In addition, 24 entries (14 first year entries, 6 second year entries, one third year entry, one fourth year entry and 2 check cultivars, OAC 21 and Bonanza) from 3 locations were malted and analyzed at the Grain Research Laboratory.

The Western Co-operative Two-Row Barley Test was grown at 11 locations in 1983 and included 25 new entries and 5 check cultivars. However only twenty entries including 7 first year, 6 second year, 3 third year and 4 check cultivars (Hannchen, Klages, Harrington and Ellice) were malted at the Grain Research Labortory and analyzed jointly at the Grain Research Laboratory and Winnipeg Research Station.

Varieties tested in pilot-scale malting and brewing studies. Barley selections to be evaluated in collaborative pilot-scale malting and brewing tests are each grown on 1/5 acre plots at several locations in Western Canada. The Brewing and Malting Barley Research Institute (BMBRI), Winnipeg, co-ordinates pilot-scale malting and brewing trials in governmental and industrial facilities.

The unfavorable growing conditions in the summer of 1983 had an adverse effect on the barley cultivars being grown for these collaborative tests; some of the cultivars at one or more locations were not harvested because of poor growth or because of hail damage. Two two-rowed selections, along with Klages as the check cultivar, from each of three locations, were malted by the research laboratory and tested for brewing performance by BMBRI. Three six-rowed selections along with Argyle as the check from one location were malted in the Research Laboratory and evaluated for brewing performance in the BMBRI. The two two-rowed selections and one six-rowed selection will be tested again.

Further evaluation of TR 212 (Ellice). Ellice is the name proposed for the two-rowed barley cultivar TR 212 when this cultivar is prescribed under the Canada Seeds Act. However, the breeder of Ellice barley has agreed to delay completion of the licensing procedure until commercial malting and brewing trials have been completed. The Canadian Seed Growers Association has agreed to slow down the increase and release of foundation seed, and the Market Development Section of the Canadian Wheat Board has agreed to contract sufficient areas of Ellice barley during the 1984 and the 1985 growing seasons to allow for carlot amounts for commercial-scale trials.

During the summer of 1983, breeder's seed of Ellice was increased at the Agriculture Canada Research Station, Regina. Sufficient seed was available for further pilot-scale evaluation of the unique steeping characteristics and the rapid germination behaviour of Ellice by Dominion Malting Ltd. and Canada Malting Co., respectively. Brewing performance of these malts was promising.

Market status of Argyle, Harrington and Norbert. On behalf of the domestic malting and brewing industries, BMBRI issued a news release in late 1984 as follows: "Results of commercial-scale malting and brewing trials conducted on the 1982 and 1983 crops indicate that Argyle and Harrington should be acceptable malting varieties. Similar trials on Norbert gave less promising results."

Argyle is a blue aleurone six-rowed variety developed as a potential replacement for Bonanza throughout the Prairie Provinces. Harrington appears to be a good replacement for Klages in the two-rowed production areas of southern Alberta and western Saskatchewan. Norbert is the first two-rowed cultivar with adequate disease resistance for production in the eastern prairies. Although malting performance was satisfactory, brewing results were inferior to Klages. Ellice is intended as a replacement for Norbert in the eastern prairies.

Feed barley cultivars supported for licensing applications. In 1983, the Expert Committees on Grain Quality, Breeding and Diseases supported breeders' applications to license four six-rowed cultivars of feed barley. BT 346 has been prescribed as Heartland and combines high yield, moderately strong straw strength and net blotch resistance and is recommended for Saskatchewan where this combination of characteristics is not readily avilable in other feed cultivars. Tupper is the name of a hulless six-rowed barley, BT 445. Tupper has a good spectrum of disease tolerance and is recommended for the Eastern Prairie region. Other cultivars approved for licensing applications are BT 657, a six-rowed, feed cultivar intended for the Peace River district, and WB 158-17, a six-rowed, winter feed barley for Ontario.

LIAISON ACTIVITIES, PUBLICATIONS, AND STAFF

SECTION 4

LIAISON ACTIVITIES

Committees

Canadian Grain Commission	
Eastern and Western Grain Standards Committees	K.H. Tipples
Agricultural Institute of Canada	
Associate Editor, Canadian Journal of Plant Science	R.R. Matsuo
Agriculture Canada	
Canada Committee on Crop Production Services	K.H. Tipples
Canada Committee on Fats and Oils	J.K. Daun
Expert Committee on Grain Quality	K.H. Tipples (Chairman) R. Tkachuk
Subcommittee on Barley	D.E. LaBerge (Chairman) A.W. MacGregor (Secretary)
Subcommittee on Oilseeds	J.K. Daun (Chairman) L.D. Burch
Subcommittee on Wheat	C.J. Dempster (Chairman - 1984) R.R. Matsuo (Chairman - 1985) R.R. Matsuo (Secretary - 1984) K.R. Preston (Secretary - 1985) K.H. Tipples
American Association of Cereal Chemists	
Technical Committees:	
Amylase Methods	J.E. Kruger A.W. MacGregor
Bread Baking Methods	R.H. Kilborn
Experimental Milling	J.E. Dexter
Methods for Grain Testing	P.C. Williams
Near-Infrared Reflectance	P.C. Williams
Pasta Products Analysis	J.E. Dexter R.R. Matsuo
Physical Testing Methods	R.H. Kilborn K.R. Preston
Quality Tests for Wheat and Flour	R. Tkachuk
Canadian Prairie Section	J.E. Dexter (Vice-Chairman) V.J. Mellish (Secretary-Treasurer)

Brewing and Malting Barley Research Institute	
Technical Committee	D.E. LaBerge
Canadian Government Interdepartmental	
PCB Committee	T.W. Nowicki
Canadian Government Specifications Board	
Technical Committee on Bakery and Cereal Products	R.R. Matsuo
Joint Committee for Direction on	
Grain Classes	K.H. Tipples (Chairman)
Subcommittee on Red Spring Wheats	R. Tkachuk
Subcommittee on Durum Wheats	R.R. Matsuo
Subcommittee on Red Winter and Soft White Wheats	R.R. Matsuo
	K.R. Preston
	P.C. Williams
Subcommittee on Barley	D.E. LaBerge (Chairman)
Subcommittee on Utility and "3M" Wheat	K.R. Preston
Subcommittee on Feed Grains	A.W. MacGregor
Codex Alimentarius Commission, FAO, WHO	
Canadian Delegation	R. Tkachuk (Chairman)
Federal Interdepartmental Committee on Pesticides Check Sample Program:	
Feeds/Grains Sub-program	T W. Nowicki (Co-ordinator)
International Association for Cereal Chemistry	
Executive Committee, Technical Committee and	
General Assembly	K.H. Tipples
Working Groups on:	
Variety Identification by Electrophoresis	R. Tkachuk
Baking Tests	K.H. Tipples (Chairman)
Determination of Wet Gluten	K.R. Preston
Particle Size	P.C. Williams
Methods of Protein Determination	R. Tkachuk
Sampling	P.C. Williams
Near-Infrared Technology	P.C. Williams
International Standards Organization	
Canadian Advisory Committee TC34/SC4	K.H. Tipples (Chairman)
Red River Community College	
Advisory Committee for Chemistry and	
Biochemical Technology	R. Tkachuk
University of Manitoba	
Adjunct Professors, Department of Plant Science	A.W. MacGregor
	R. Tkachuk
	P.C. Williams

Conferences and Meetings

American Association of Cereal Chemists	
Annual Meeting, St. Paul, MN	J.E. Dexter
	V.J. Mellish
	K.R. Preston
	K.H. Tipples
	R. Tkachuk
	P.C. Williams
Milling and Baking Technical Conference, Omaha, NB	R.H. Kilborn

American Association of Plant Physiologists
Annual Meeting, Davis, CA ..... J.E. Kruger

American Barley Research Workshop
Williamsburg, VA ..... D.E. LaBerge
B.A. Marchylo

American Oil Chemists Society
Annual Meeting, Dallas, TX ..... J.K. Daun

American Society of Bakery Engineers
Annual Meeting, Chicago, IL ..... R.H. Kilborn

American Statistical Association
Annual Meeting, Philadelphia, PA ..... J.C. Babb

Association of Official Analytical Chemists
Annual Meeting, Washington, DC ..... T.W. Nowicki

Association of Operative Millers
Annual Conference, Minneapolis, MN ..... D.G. Martin
Joint Meeting with American Association of Cereal Chemists, Toronto, ON ... K.R. Preston

Barley Improvement Conference
Annual Meeting, Minneapolis, MN ..... D.E. LaBerge

Brewing Congress of the Americas
First Congress, St. Louis, MO ..... B.A. Marchylo

Canadian Barley and Oilseed Conference
Winnipeg, MB ..... S. Gowan
D.E. LaBerge
B.A. Marchylo
A.D. Mitchelson
M. Stethem

Codex Alimentarius Commission Meeting
Washington, D.C. ..... R. Tkachuk

Chemical Congress of Pacific Basin Societies
1984 International Meeting, Honolulu, HI ..... J.K. Daun

1984 Consultation of the European Co-operative
Network on Durum Wheat, Nicosia, Cyprus ..... J.E. Dexter

Expert Committee on Grain Quality
1984 Meeting , Winnipeg, MB ..... L.D. Burch
J.K. Daun
C.J. Dempster
D.E. LaBerge
A.W. MacGregor
R.R. Matsuo
K.R. Preston
K.H. Tipples
R. Tkachuk
1985 Meeting, Saskatoon, SK ..... L.D. Burch
J.K. Daun
D.E. LaBerge
A.W. MacGregor
R.R. Matsuo
K.R. Preston
K.H. Tipples
R. Tkachuk

Hard Wheat Quality Conference
Manhattan, KS ..... K.R. Preston

Institute for Cereal Research
Durum and Pasta Meeting, Detmold, Fed. Rep. of Germany ..... J.E. Dexter

Institute of Food Technologists
Annual Conference, Anaheim, CA ..... C.J. Dempster
International Association for Cereal Chemistry
11th Congress, Vienna, Austria ..... K.H. Tipples
International Conference on New Approaches to Research on Cereal Carbohydrates
Copenhagen, Denmark ..... A.W. MacGregor
International Diffuse Reflectance Symposium
Chambersburg, PA ..... P.C. Williams
International Symposium on Advances in Baking
Science and Technology, Manhattan, KS ..... K.R. Preston
K.H. Tipples
International Symposium on HPLC of Proteins,
Peptides and Polynucleotides, Baltimore, MD ..... J.E. Kruger
International Workshop on Gluten Proteins
Wageningen, Netherlands ..... K.R. Preston
Master Brewers' Association of the Americas
Eastern Canada District Annual Meeting, St. John's NF ..... D.E. LaBerge
National Conference on Weights and Measures
69th Meeting, Sacramento, CA ..... C.J. Dempster
Pittsburg Conference on Analytical Chemistry
Atlantic City, GA ..... J.E. Kruger
Spring Wheat Quality Advisory Council
1984 Meeting, Fargo, ND and 1985 Meeting, Minneapolis, MN ..... K.R. Preston
Starch/Science Technology Conference
Minneapolis, MN ..... A.W. MacGregor
Western Canada Pesticide Residue Analysis
1984 Workshop, Saskatoon, SK ..... T.W. Nowicki
World Congress on Food Technology
Buenos Aires, Argentina ..... K.H. Tipples

LIST OF PUBLICATIONS

Scientific Papers

No.

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523 PRESTON, K.R. Gel Filtration and Characterization of Neutral Salt- Extracted Wheat Gluten Proteins Varying in Hydrophobic Properties. Cereal Chem. 61(1):76-82 (1984).

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531 MacGREGOR, A.W., MacDOUGALL, F.H., MAYER, C. and DAUSSANT, J. Changes in Levels of Alpha-Amylase Components in Barley Tissues during Germination and Early Seedling Growth. Plant Physiol. 75:203-206 (1984).

532 DAUN, J.K. and BURCH, L.D. Oilseeds Grading - Quality Control in Oilseeds Marketing. JAOCS 61(6):1117-1122 (1984).

533 JENSEN, S.Aa., MUNCK, L. and KRUGER, J.E. A Rapid Fluorescence Method for Assessment of Pre-Harvest Sprouting of Cereal Grains. J. Cereal Sci. 2:187-201 (1984).

534 NORRIS, H.K. and WILLIAMS, P.C. Optimization of Mathematical Treatments of Raw Near-Infrared Signal in the Measurement of Protein in Hard Red Spring Wheat. I. Influence of Particle Size. Cereal Chem. 61(2):158-165 (1984).

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541 CASUTT, V., PRESTON, K.R. and KILBORN, R.H. Effects of Fermentation Time, Inherent Flour Strength, and Salt Level on Extensigraph Properties of Full-Formula Remix-to-Peak Processed Doughs. Cereal Chem. 61(5):454-459 (1984).

542 DEXTER, J.E., PRESTON, K.R., MATSUO, R.R. and TIPPLES, K.H. Development of a High Extraction Flow for the GRL Pilot Mill to Evaluate Canadian Wheat Potential for the Chinese Market. Can. Inst. Food Sci. Technol. J. 17:253-259 (1984).

543 PRESTON, K.R., MYDLO, E. and KILBORN, R.H. Remix and Remix-to-Peak Baking Methods: Effects of Fermentation Time and Salt on Baking Properties of a Canadian Bread Wheat. Can. Inst. Food Sci. Technol. J. 17:260-265 (1984).

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Miscellaneous Papers

M132 KRUGER, J.E. Model Systems for a Better Understanding of the Enzymic Degradation of Starch During Breadmaking. In *General Polysaccharides: Their Role in Technology and Nutrition*, published by The American Association of Cereal Chemists, Inc., St. Paul, MN, pp 23-34 (1984).

M134 DAUN, J.K. Composition and use of Canola Seed, Oil, and Meal. Cereal Foods World 29(5):291-296 (1984).

M136 DEXTER, J.E. Development of Quality Durum Wheat Varieties in Canada. Rachis 3(2):23-28 (1984).

M137 PRESTON, K.R., KILBORN, R.H. and TIPPLES, K.H. Effects of Fermentation, Sponge Salt and Oxidation on Sponge-and-Dough Bread Quality. In: *Proceedings of International Symposium on Advances in Baking Science and Technology, Manhattan, KS*, published by Kansas State University Press, pp. M1-M9 (1984).

M139 WILLIAMS, P.C. A Study of Grinders used for Sample Preparation in Laboratory Analysis of Grains. Cereal Foods World 29(12):770-775 (1984).

M140 PRESTON, K.R. and KILBORN, R.H. Dough Rheology and the Farinograph. In: *The Farinograph Handbook*, Third Edition, published by The American Association of Cereal Chemists, Inc., St. Paul, MN, pp 38-42 (1984).

Periodical Publications

Fifty-seventh Report

TIPPLES, K.H., Grain Research Laboratory 1983 Report, Canadian Grain Commission.

1984 Wheat Protein Maps and Crop Bulletins

Map of Western Canada showing the protein content of No. 1 C.W. red spring wheat, 1984 crop. Grain Research Laboratory, Canadian Grain Commission.

Map of Western Canada showing the protein content of No. 2 C.W. red spring wheat, 1984 crop. Grain Research Laboratory, Canadian Grain Commission.

Map of Western Canada showing the protein content of all grades of red spring wheat, 1984 crop. Grain Research Laboratory, Canadian Grain Commission.

Quality of 1984 Western Canadian Grain Crops - Preliminary Report. Grain Research Laboratory, Canadian Grain Commission.

Quality of 1984 Canadian Soybean Crop. Grain Research Laboratory, Canadian Grain Commission.

No.

162 Canadian Red Spring Wheat 1984. Grain Research Laboratory, Canadian Grain Commission.
Blè roux canadien de printemps rècolte de 1984. Laboratoire de recherches sur les grains, Commission canadienne des grains.

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164 Canadian Barley 1984. Grain Research Laboratory, Canadian Grain Commission.
Orge canadienne 1984. Laboratoire de recherches sur les grains, Commission canadienne des grains.

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Red Spring and Amber Durum Wheat Cargo Bulletins

218 Canadian Wheat Cargoes 1983-84, second quarter (Nov. 1 to Jan. 31). Grain Research Laboratory, Canadian Grain Commission.
(English-French-German-Spanish edition, English-Japanese edition and English-Chinese edition).

219 Canadian Durum Cargoes 1983-84, first and second quarters (Aug. 1 to Oct. 31). Grain Research Laboratory, Canadian Grain Commission. (English-French-German-Italian edition).

220 Canadian Wheat Cargoes 1983-84, third quarter (Feb. 1 to April 30). Grain Research Laboratory, Canadian Grain Commission. (English-French-German-Spanish edition, English-Japanese edition and English-Chinese edition).

221 Canadian Wheat Cargoes 1983-84, fourth quarter (May 1 to July 31). Grain Research Laboratory, Canadian Grain Commission. (English-French-German-Spanish edition, English-Japanese edition and English-Chinese edition).

222 Canadian Durum Cargoes 1983-84, third and fourth quarters (Feb. 1 to July 31). Grain Research Laboratory, Canadian Grain Commission. (English-French-German-Italian edition).

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STAFF

Executive of the Canadian Grain Commission

H.D. Pound	Chief Commissioner
G.G. Leith	Commissioner
Elizabeth Candlish, Ph.D.	Commissioner
W.J. O'Connor	Executive Director

Staff of Grain Research Laboratory

K.H. Tipples, B.Sc., Ph.D.	Director
Joyce Ramsay, Mary Kowcun*	Secretary
N.H. Barchuk, B.Sc.	Special Assistant to the Director (Scientific)

Administration

Doreen Routley	Assistant Director, Administration
Karen Tait, Reta Rippin*	Office Manager
Jane Melnyk*, Brenda Mercer, Marge Pewarchuk, D.J. Van Norman, Christina Little	Clerks
Kathi Suderman	Word Processing
Marvyn Lick, Dipl. A.A., Valerie McKinnon	Secretaries
Patricia Demler, Joyce Johnston*	Casual Assistants

Analytical Methods Development

P.C. Williams, B.Sc.,Ph.D.	Research Scientist
Janet Panford, B.S.A., M.Sc.	Chemist
W. Podolak	Senior Technologist
Patricia Starkey, C.J. Ashley, Helena Cordeiro, F.Y. Lim, L.G. Oneschuk, Carole Panting, Debbie Sobering, B.Sc., R.K. Brady, D.M. Bulloch*, B.Sc., G. Holowka, B.A., Klara Jarrin, Jean McGill, E. Padilla, S. Schroeder, J.P. Yau	Scientific Support
Cheryl McClure*, G.R. Hennessey*, L. Kawchuk**, W. Harnden, T. Warkentin*, Janice Craig	Casual Assistants

Barley - Basic Research

A.W. MacGregor, B.Sc.,Ph.D.	Research Scientist
L. Dushnicky, B.Sc., Joan Morgan, Helen MacDougall	Scientific Support
R.J. Weselake*, B.Sc., M.Sc.	Casual Assistant

Barley - Malting and Quality Studies

D.E. LaBerge, B.Sc.,M.Sc.,Ph.D.	Research Scientist
A.D. Mitchelson, D.E. Langrell, Maureen Stethem, J.R. Bethune	Scientific Support
Cheryl Gillespie**	Casual Assistant

Barley - Varietal Identification

B.A. Marchylo, B.Sc., M.Sc., Ph.D.	Research Scientist
Sandra Gowan, Dipl.T.	Scientific Support
Louise Cooke*, B.S.A.	Casual Assistant

Bread Wheat Quality Studies

K.R. Preston, B.Sc.,M.Sc.,Ph.D.	Research Scientist
B.C. Morgan, B.Sc.	Chemist
E. Mydlo, P.Y.M. Lee*, B.Sc., L. Minty, I. Phillips, C. Taplin	Scientific Support
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Breadmaking Research

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Durum Wheat

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Flour Milling

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D.G. Martin*	Senior Technologist
Nancy Edwards, Dipl.T., B.Sc., R.J. Desjardins, J.J. Lachance, P.V. Harbun, D.R. Ouellette, D.R. Newediuk*	Scientific Support

Information and Support Services

C.J. Dempster, B.Sc.,Ph.D.	Chemist
J.C. Babb, B.Sc., M.Sc.	Statistician
P.R. March, B.Sc.	Chemist
H.E. Hughes, G.G. Baker, H. Zimberg, R.J. Wallis, Diana Chance, B.I.D.	Scientific Support
Adeline Armstrong, Caroline Rebizant	Clerks
W.G. Chao**, Wilna Dehls*, B.J. Gillespie**	Casual Assistants

Oilseeds

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Lynda Burch, B.S.A.	Chemist
D.R. DeClercq, B.Sc., P.B. Mazur, H.K. Howard, B.A. Misener, Kathleen Clear, B.S.A.	Scientific Support

Residue Analysis

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D.G. Gaba, B.Sc.	Chemist
Janyce Thorsteinson, Dipl.T., D.L. Parent	Scientific Support

Wheat Chemistry

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Jean Mellish, B.Sc.	Chemist
F.D. Kuzina	Senior Technologist
Shirley Lowe, B.Sc., G.G. Bell, Dipl.T., K.A. Handel, Dipl.T.	Scientific Support
Deanna Derksen*, Kathryn Kidd	Casual Assistants

Mycology

R.M. Clear, B.Sc.	Mycologist

Wheat Enzymes

J.E. Kruger, B.Sc.,M.Sc.,Ph.D.,M.C.I.C. . . . . Research Scientist
D.W. Hatcher, B.Sc., M.Sc. . . . . Chemist
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**Career-Oriented Summer Employment Program.